Establishment Record for Mill Creek Gorge Research Natural Area within Manti-La Sal NF

COOP AGREEMENT NATURE CONSERVANCY

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ESTABLISHMENT RECORD FOR MILL CREEK GORGE RESEARCH NATURAL AREA WITHIN MANTI-LA SAL NATIONAL FOREST SAN JUAN COUNTY, UTAH

INTRODUCTION

The La Sal Mountains are a range of intrusive igneous rocks that rise abruptly above the general level of the Colorado Plateau in southeastern Utah. Surrounding the high summits of the peaks, various plateaus and tablelands of sedimentary composition fall off toward the arid canyon country that encircles this island range. The flanks of the range are mantled with coniferous forests, aspen groves, oak-serviceberry shrublands, piñon-juniper woodlands and sagebrush stands. Streams descending steeply from their mountain headwaters have cut deep canyons and gorges in a number of locations around the periphery of the range.

The first human occupancy in the region adjacent to the La Sal Mountains was by prehistoric pueblo people in the first millennium A.D. These people disappeared about 700 years ago. Sparse populations of Utes and Paiutes were in the area when the first white men brought livestock through in the 1820's-30's. Permanent settlement by colonists of the LDS Church was attempted about 30 years later. The first settlement in the Moab area failed in the 1850's, but was re-established in the late 1870's when cattlemen moved into the region.

Settlement has been sustained mostly by reliance on the area's natural resources. Ranching and farming were the basis for much of the settlement and continue to be practiced. Mining activity was at a peak in the 1950's and 60's, but is now at a low ebb. Tourism began to be an important industry for the Moab area in the 1960's, and now in the late 1990's is the dominant segment of the local economy. The La Sal Mountains continue to provide commodity and non-commodity resources that help to sustain life in the region. The non-mineral resources of much of this range are administered by the Manti-La Sal National Forest, created in 1949 by consolidation of the old Manti and La Sal National Forests.

Complementing the multiple use of resources is a need to maintain undisturbed examples of the area's natural diversity. A means of accomplishing this on National Forest lands is through administrative designation of Research Natural Areas (RNAs). These serve to register and protect certain ecosystems as benchmark or reference areas.

The deep gorge carved by Mill Creek as it flows westward from the high La Sal peaks has been subject to little resource use or development due to its rugged terrain and relatively isolated position. The author of this Establishment Record learned of the little-disturbed condition of this site in the early 1990's, and suggested to the Manti-La Sal National Forest that it might make a good RNA. The author made several visits to the area in 1997, including both the canyon bottom and the upper rims of the gorge. These visits confirmed that the site was potentially worthy of RNA status. A subsequent site visit was made with the Moab/Monticello District Ranger, to view the features of the area and discuss prospective RNA boundaries. Mill Creek Gorge has been included in a Region-wide initiative to achieve RNA designation for qualified sites that had not been identified as candidates in National Forest Plans. The opportunity now exists to recognize and protect the values of this site by designating it as the Mill Creek Gorge Research Natural Area (MCGRNA).

The MCGRNA consists entirely of reserved lands of the Manti-La Sal National Forest. It is not within nor does it contain any Congressionally-designated areas such as Wilderness, National Recreation Area or Wild and Scenic River.

Land Management Planning

The Regional Guide for the Intermountain Region (USDA Forest Service 1984) includes policy, general guidance, and Regional planning requirements for RNAs. The more recent Regional Desk Guide (USDA Forest Service 1993a) reiterates that selection and establishment of RNAs shall be a part of the continuing land and resource management planning process. Relevant portions of these Regional documents are included in Appendix A.

The Manti-La Sal National Forest Land and Resource Management Plan ("Forest Plan"; USDA Forest Service 1986b) and Environmental Impact Statement (USDA Forest Service 1986a) contain more-specific policy and guidance for the establishment and management of RNAs on the Forest. Selected materials pertaining to RNAs from these two documents are included in Appendix B.

The Mill Creek Gorge site was nominated as a candidate RNA as part of the continuing management planning process. However, it is not identified as a candidate RNA in the current Forest Plan. At present, the Forest Plan identifies Mill Creek Gorge as being within Management Area SPR, where emphasis is on providing semi-primitive recreation use. As explained later in this Record, however, there is little recreational use in the part of Mill Creek Gorge within the RNA boundary, and conflicts between recreation and the values that make this site qualified for RNA status are minimal.

The environmental analysis and recommendations necessary for designating the Mill Creek Gorge site as an RNA are contained within an Environmental Assessment (USDA Forest Service 1998b; Appendix C) and Manti-La Sal National Forest Plan Amendment (USDA Forest Service 1998a; Appendix D). The result of these analyses and the subsequent decision is to change the status of the Mill Creek Gorge site to Management Area RPI (**R**esearch, **P**rotection and **I**nterpretation), specifically as a Research Natural Area unit in which research and protection are emphasized.

OBJECTIVES

The chief objective of the Mill Creek Gorge RNA is to preserve and maintain in undisturbed, naturally-functioning condition the biological and genetic diversity present within exemplary vegetation types and habitat occurrences within the area. These include examples of riparian and terrestrial woodlands and shrublands, plus distinctive landform, soil and geologic types.

Establishment and protection of the MCGRNA will further the long-term objective of setting aside at least one example of all the habitat or vegetation community types represented on National Forest lands in Utah or Region 4 (Federal Committee on Ecological Reserves [FCER] 1977). As explained in the following section, the MCGRNA contains three vegetation types that would be new to the RNA system within the Northern Canyonlands geographic Section, and two types that would add desired redundancy to the system.

The MCGRNA will also provide a reasonably accessible reference site for basic, non-manipulative studies of biotic patterns, ecological processes, natural disturbance regimes, and community succession. Left undisturbed by human intrusions, it will afford managers and conservation scientists a benchmark for assessing long-term ecological and geomorphological changes, plus inherent productivity (Passey et al. 1982). Such a benchmark would be especially useful for comparing the effects of resource management techniques and practices on grazed or wooded lands nearby (Johnson 1989).

JUSTIFICATION STATEMENT FOR ESTABLISHMENT OF AREA

An initial estimate of RNA needs in Utah and Nevada found that woodlands indicative of pre-settlement conditions on the Colorado Plateau (including the high laccolithic mountains) were key RNA needs (Van Pelt 1982, Table 26). A few cells of this type have been filled since the date of that initial estimate, via designation of RNAs such as Cliffdweller's Pasture and Mount Peale on the Manti-La Sal National Forest. Many of these key RNA needs remain unfilled, however.

A recent analysis of RNA needs on National Forest lands in Utah (Tuhy 1998) focused on vegetation types as the cells to be targeted for inclusion in the RNA system, segregated according to geographic divisions of the state known as Sections (McNab and Avers 1994). This analysis found that designation of the MCGRNA would fill three new cells within the Northern Canyonlands Section, and provide desired redundancy for two more cells. Table 1 shows the specific cells that are represented in the MCGRNA, and what they bring to the RNA system.

Pertinent excerpts from the initial RNA needs estimate (Van Pelt 1982) and from the recent analysis (Tuhy 1998) are included in Appendix E, as documentation of the needed natural diversity elements.

Table 1. Specific cells represented in the Mill Creek Gorge RNA, and what they add to the RNA system.

	WITHIN GEOGRAPHIC SECTION:	
CELLS - VEGETATION TYPES	FILLS NEW CELL	ADDS DESIRED REDUNDANCY
SHORT FOREST, WOODLAND AND SHRUBLAND COMMUNITIES		
Acer negundo (box elder)	X	
Betula occidentalis (water birch)		X
Pinus edulis-Juniperus osteosperma/Ephedra viridis-Yucca baccata (two-needle piñon pine-Utah juniper/green ephedra-datil yucca)	X	
Quercus gambelii-Acer grandidentatum (Gambel oak-bigtooth maple)		X
Quercus gambelii-Cercocarpus montanus-Amelanchier utahensis (Gambel oak-birchleaf mountain mahogany-Utah serviceberry)	X	

Designation of the MCGRNA would also add a number of landform and geologic cells to the RNA system, according to the classifications in FCER (1977; pp. 14-19). Because these cell categories are not well-defined within the FCER document, however, a listing of such specific abiotic cells present in the MCGRNA is not given here.

Another justification for establishment of the MCGRNA involves the use of the area for research. Though no studies are known to be taking place within the area at the present time, the MCGRNA could support extensions of existing, localized research focusing on specific communities and their ecotones. Examples of such research include Austin (1987); Brotherson et al. (1984); and Greenwood and Brotherson 1978.

PRINCIPAL DISTINGUISHING FEATURES

The MCGRNA encompasses much of the deep gorge that has been carved by Mill Creek through several thick layers of sandstone on the west side of the La Sal Mountains. Two of these sandstone strata form prominent cliffs that define an upper subsection and a lower, "inner" subsection of the gorge (Photos 1 and 7).

Mill Creek itself is a steep-gradient stream with very little floodplain, and is flanked by tall thickets of riparian shrub and tree species (Photos 3 and 4). The general east-west orientation of the gorge results in a striking contrast of vegetation and erosional features between its north and south sides (Photo 2). The north side of the gorge (south-facing) is largely covered with sparse to moderately dense woodlands of piñon and juniper, and cliff faces are generally higher, more sharply defined and more laterally continuous. The south side (north-facing) largely supports mesic mountain brush species (such as Gambel oak, Utah serviceberry and birchleaf mountain mahogany), plus individual trees and small stands of Douglas-fir in the coolest/wettest microsites. The south-side cliffs also tend to be lower and less continuous, owing to the greater effectiveness of erosion that has created more vegetation-mantled colluvial slopes than on the north side of the gorge.

Some past cattle grazing has occurred on narrow stream terraces in the lower end of the gorge, resulting in the presence of some dense patches of exotic species, but such use has ceased. A few mineral-exploration trails also exist next to the RNA boundary along the upper north and south rims of the gorge. Apart from these minor features, however, most of the gorge within the MCGRNA is in little-altered or pristine condition.

LOCATION

The Mill Creek Gorge RNA is located on the Moab portion of the Moab/Monticello Ranger District of the Manti-La Sal National Forest. [Note: Elsewhere in this Record the "Moab portion of the Moab/ Monticello Ranger District" is referred to as the "former Moab Ranger District".] The RNA lies about 12 miles (19 km) southeast of Moab, in extreme northern San Juan County (Maps 1-3). Latitude and longitude for the approximate center of the area are 38°29'30" North and 109°20'30" West, respectively. Specifically, the area lies in portions of sections 35 and 36 (T26S R23E); section 31 (T26S R24E); sections 1 and 2 (T27S R23E); and section 6 (T27S R24E); Salt Lake Meridian (Maps 3-4). It is shown on the Mt. Tukuhnikivatz 7.5' topographic quadrangle. Stereo coverage is provided by eight aerial photographs, housed at the Moab field office of the Ranger District:

7-31-89	USDA-F	16 614104	189-114 through 189-116
9-9-89	USDA-F	16 614104	289-101 through 289-103
9-9-89	USDA-F	16 614104	289-135 through 289-136

The boundary of the MCGRNA (Map 4) follows generally well-defined cliff rims and spur ridge crests for much of its length. The western boundary corresponds with the Manti-La Sal National Forest boundary. RNA boundary segments in the upper eastern end of the area follow contour lines that generally correspond with low cliff bands, which are discontinuous or masked by dense vegetation in

some locations. A description of this boundary is provided in Appendix F. The boundary shown on Map 4 encompasses an area of 680 acres (275 ha). Elevation ranges from about 5780 feet (1760 m) where Mill Creek crosses the western boundary of the area, up to 7640 feet (2330 m) along the northeastern margin of the area. This represents a vertical relief of about 1860 feet (570 m).

The most direct access to the bottom of the gorge at the lower, western end of the RNA requires considerable foot travel, the majority of which is through private land. From Moab, drive out the Spanish Valley road and take the spur road toward Ken's Lake. Proceed past the turnoff to Ken's Lake, and follow the gravel road up over the pass and down the short hill to Mill Creek. It should be possible to reach this point with any type of vehicle, even passenger cars, though some of the grades on the gravel road are steep and may become rutted. Leading eastward is a primitive road along the south side of Mill Creek that can be driven for a short ways by high-clearance vehicles, though in no case can one drive up the drainage of Mill Creek beyond where the vehicle track crosses the creek and heads off northward.

Continue walking up the valley bottom of Mill Creek on a trail, which may be indistinct in places and which fords the creek once. This trail crosses through two separate tracts of private land, and it may be wise to check with local Forest officials about the current state of access across these lands. Eventually one reaches the Forest boundary and the beginning of the MCGRNA. Field inspectors found the brass-cap survey marker on the quarter corner between sections 2 and 3 (T27S R23E) -- representing a point on the official Forest boundary -- a short ways up the slope from the foot path, but this marker is easy to miss. This foot path continues upstream along the terrace on the north side of Mill Creek for well over a mile, though it becomes indistinct and easy to lose in a number of spots. The creek itself can be forded in places, though it would be hazardous in times of high runoff.

It also may be possible to reach the lower end of the gorge bottom directly from above, by descending through breaks in the otherwise continuous sandstone cliffs that occur on both the north and south sides of the gorge. These breaks correspond with places where two northwest-southeast-trending faults cross through the gorge, in section 35 (T26S R23E) and sections 1 and 2 (T27S R23E). One of these breaks is shown toward the right side of Photo 1, where the cliffs of the Entrada/Moab Member are visibly offset. Although it appeared possible to make these descents without need for ropes or technical climbing equipment, these routes would be extremely steep, rugged, brush-infested (on the south side) and arduous. Reaching the cliff-rim beginning points for these descents also involves some cross-country walking from the ends of spur roads off the La Sal Loop Road (see the following two paragraphs).

Access to the upper rims of the gorge can be accomplished from a number of spur routes off the paved La Sal Loop Road. The primary spur on the south side is shown as Forest Road #682 on the Forest Travel Map. It leaves the Loop Road in the SE¼ NE¼ of section 1 (T27S R23E), but has a locked gate across it within about ⅛ mile (0.2 km); this gate is **not** on the boundary of the private inholding through which this spur road crosses farther on. One can walk down this road which generally parallels the southern MCGRNA boundary, and descend into the RNA in various spots. These high southern (north-facing) slopes of the RNA are largely covered with thick brush that tends to hinder foot travel. It is also possible to walk down old mineral-exploration tracks from a point on the Loop Road across from the turnoff to Geyser Pass. Some route-finding is necessary, though one can reach the southeasternmost portion of the MCGRNA this way.

Two spur routes to the upper north rim of the gorge follow Forest Roads #684 and 651, respectively. The former leaves the Loop Road a short ways east of the turnoff to Warner Lake, while the latter is a spur off the main graveled road onto South Mesa. As on the south side, one can use route-finding skills to reach points within the MCGRNA by descending slopes off the rim on the north side of the gorge.

Access to the bottom of the gorge in the upper end of the MCGRNA is more problematic. It may be possible to find ways down over the Entrada/Moab Member cliff band (see **Geology** subsection) where it

is particularly low; one such place is just in from the eastern RNA boundary on the south side of the gorge. Alternatively, one can easily drop into Mill Creek at the Loop Road bridge, and then proceed with greater difficulty downstream the one mile (1.6 km) or so to reach the eastern end of the RNA. This route has not been traveled by the author of this Establishment Record, but reports indicate that it is exceedingly laborious, involving much scrambling over boulders and log jams directly in the creek, or beating through thick brush beside the creek.

AREA BY COVER TYPES

The extent and distribution of vegetation cover types in the MCGRNA has been derived from field surveys and subsequent aerial photo interpretation. Several systems for classifying such types are considered, as discussed below.

The Society of American Foresters cover type classification (Eyre 1980) applies to portions of the MCGRNA that support coniferous forests and woodlands. The scattered patches of Douglas-fir on north-facing slopes of the gorge belong to SAF Type 210: Interior Douglas-fir. Extensive woodlands of two-needle piñon pine and Utah juniper in the gorge belong to SAF Type 239: Pinyon-Juniper. The extensive mountain brush and tall riparian shrub communities of the MCGRNA are not considered in the SAF system.

The classification of potential natural vegetation by Küchler (1966) applies somewhat more comprehensively to the vegetation of the MCGRNA. The patches of Douglas-fir probably correspond to Type 19: Spruce-Fir-Douglas fir Forest, though spruce and fir are absent. [Another possibility for these patches is Type 11: Douglas-fir Forest, though that type is principally located in Washington and the northern Rocky Mountains.] Piñon-juniper woodlands correspond to Type 21: Juniper-Pinyon Woodland. Woodlands of Gambel oak, accompanied in various habitats by birchleaf mountain mahogany, Utah serviceberry, bigtooth maple, and skunkbush, generally correspond to Type 31: Mountain Mahogany-Oak Scrub. Finally, neither the riparian shrub communities of boxelder and water birch nor the areas of sparsely-vegetated rock outcrop appear to correspond to any Küchler type.

Table 2 shows the estimated areas of vegetation types defined by the SAF and Küchler systems described above. The distribution of vegetation cover types in the MCGRNA is shown on Map 5 (scattered areas of nearly-bare rock outcrop have been included in their respective types, mostly the piñon-juniper type). Table 2 and the legend of Map 5 both display the correspondence ("cross-walking") between the SAF and Küchler classification schemes for forest types.

Beyond the SAF and Küchler classification systems, more-detailed descriptions of the MCGRNA's vegetation communities were made based on: (1) floristic composition observed during the field work done for this Establishment Record; and (2) pertinent classification studies such as that of Padgett et al. (1989). These more detailed descriptions are contained in the **Flora and Communities** subsection of this Record.

PHYSICAL AND CLIMATIC CONDITIONS

The MCGRNA encompasses much of the gorge that has been carved by Mill Creek through several thick layers of sandstone on the west side of the La Sal Mountains (Photos 1, 2 and 7). The gorge is mostly less than ½ mile (0.8 km) wide, and up to 1200 feet (365 m) deep. Two distinct sandstone layers form prominent, nearly-vertical cliffs that define an upper subsection of the gorge in the eastern third of the area, and a lower, "inner" subsection of the gorge in the area's central and western portions. Steep colluvial slopes lie between and above these prominent cliff lines.

Table 2. Estimated areas of SAF and Küchler types, plus types not covered by either system, in the Mill Creek Gorge RNA.

COVER TYPE	TYPE NUMBER SAF (1980)	Küchler (1966)	ESTIMATED AREA Acres	Hectares
Douglas-fir	210	19	75	30
Piñon-juniper	239	21	460	187
Gambel oak, mountain brush	---	31	100	40
Riparian shrub (boxelder, water birch)	---	--	15	6
Sparsely-vegetated rock outcrop	---	--	30	12
		TOTAL	680	275

The general east-west orientation of the gorge creates a contrast of landform features between its north and south sides. On the north side of the gorge (facing south), the cliff faces are generally higher, more sharply defined and more laterally continuous; several incipient alcoves have been formed in these north-side cliffs. The south-side (north-facing) cliffs tend to be lower and less continuous, owing to the greater effectiveness of erosion that has created more extensive colluvial slopes (mantled with thicker vegetation) than on the north side of the gorge. The south side of the gorge also contains seeps and raw slide areas in a few locations.

Flowing through the bottom of the gorge, Mill Creek is a steep-gradient, perennial stream flanked by tall thickets of riparian shrub and tree species. There is little or no floodplain development in the gorge bottom, although narrow, gently-sloping terraces adjoin the stream channel in the lower end of the gorge.

The former Moab Ranger District's Soils Report describes the climate in and around the La Sal Mountains. Located on the lower western margin of these mountains, the MCGRNA is subject to relatively cool winters. Summers are characterized by warm to hot temperatures and scattered but intense thunderstorms. An isohyetal map in the District Soils Report shows that average annual precipitation is about 16 inches (41 cm) in the MCGRNA. Another map that depicts length of growing season shows that the MCGRNA averages between 90 and 120 frost-free days per year.

The National Weather Service (NWS) and USDA Natural Resources Conservation Service (NRCS) monitor climatic data at several installations surrounding the MCGRNA. Table 3 shows the name, record length, elevation, and location relative to the MCGRNA for two NRCS snotel sites and seven NWS stations in the vicinity. Tables 4-6 contain average climatic data for these sites as posted on the internet. Those who use the MCGRNA for research may want to access these internet sites directly for climatic information, rather than relying on the summaries in Tables 4-6. The internet addresses are www.utdmp.utsnow.nrcs.usda.gov for the NRCS snotel site in Utah, ftp://ftp.wcc.nrcs.usda.gov/data/snow/ads/co for the snotel site in Colorado, and wrcc.sage.dri.edu (Western Regional Climate Center) for the NWS stations.

Table 3. Site data for climatic installations in the vicinity of the MCGRNA.

SITE NAME	RECORD LENGTH	ELEVATION	LOCATION RELATIVE TO MCGRNA
NRCS SNOTEL			
La Sal Mountain (UT)	1980-Present	9850 ft/3000 m	4 miles (6 km) to ESE
Columbine Pass (CO)	1987-Present	9140 ft/2785 m	52 miles (83 km) to E
NWS STATIONS			
Castle Valley	1978-Present	4720 ft/1440 m	12 miles (19 km) to NNW
Castleton	1963-1978	5900 ft/1800 m	8 miles (13 km) to NNE
La Sal	1949-1978	6980 ft/2130 m	13 miles (21 km) to SSE
La Sal 2 SE	1978-Present	6720 ft/2050 m	15 miles (24 km) to SSE
Moab	1928-Present	4020 ft/1225 m	13 miles (21 km) to NW
Gateway (CO)	1948-Present	4550 ft/1385 m	24 miles (38 km) to NE
Uravan (CO)	1960-Present	5010 ft/1525 m	34 miles (54 km) to ESE

Table 4. Average monthly precipitation data for two SNOTEL sites in the vicinity of the MCGRNA.

SITE NAME												
OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
LA SAL MOUNTAIN												
2.6 in 66 mm	2.9 in 74 mm	2.5 in 64 mm	2.3 in 58 mm	2.5 in 64 mm	4.0 in 102 mm	3.0 in 76 mm	2.5 in 64 mm	1.3 in 33 mm	2.4 in 61 mm	2.3 in 58 mm	2.2 in 56 mm	30.5 in 775 mm
COLUMBINE PASS												
4.3 in 109 mm	2.8 in 71 mm	3.6 in 91 mm	3.7 in 94 mm	2.7 in 69 mm	4.3 in 109 mm	4.4 in 112 mm	1.6 in 41 mm	1.9 in 48 mm	1.8 in 46 mm	2.7 in 69 mm	1.3 in 33 mm	35.1 in 892 mm

Table 5. Average monthly precipitation data for seven NWS sites in the vicinity of the MCGRNA.

SITE NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
CASTLE VALLEY	0.68 in 17 mm	0.75 in 19 mm	1.18 in 30 mm	1.01 in 26 mm	1.25 in 32 mm	0.45 in 11 mm	0.83 in 21 mm	0.83 in 21 mm	0.99 in 25 mm	1.50 in 38 mm	1.18 in 30 mm	0.71 in 18 mm	11.33 in 288 mm
CASTLETON	0.60 in 15 mm	0.55 in 14 mm	1.03 in 26 mm	1.39 in 35 mm	1.15 in 29 mm	1.14 in 29 mm	1.50 in 38 mm	1.41 in 36 mm	0.95 in 24 mm	1.73 in 44 mm	1.23 in 31 mm	0.94 in 24 mm	13.62 in 346 mm
LA SAL	1.01 in 26 mm	0.76 in 19 mm	0.70 in 18 mm	0.93 in 24 mm	0.96 in 24 mm	0.77 in 20 mm	1.29 in 33 mm	1.50 in 38 mm	1.06 in 27 mm	1.92 in 49 mm	0.90 in 23 mm	1.05 in 27 mm	12.84 in 326 mm
LA SAL 2 SE	0.95 in 24 mm	0.81 in 21 mm	1.06 in 27 mm	0.99 in 25 mm	1.08 in 27 mm	0.76 in 19 mm	1.37 in 35 mm	1.57 in 40 mm	1.75 in 44 mm	1.90 in 48 mm	1.32 in 34 mm	0.77 in 20 mm	14.32 in 364 mm
MOAB	0.58 in 15 mm	0.55 in 14 mm	0.76 in 19 mm	0.85 in 22 mm	0.72 in 18 mm	0.42 in 11 mm	0.68 in 17 mm	0.88 in 22 mm	0.78 in 20 mm	1.06 in 27 mm	0.71 in 18 mm	0.63 in 16 mm	8.60 in 218 mm
GATEWAY	0.76 in 19 mm	0.67 in 17 mm	1.04 in 26 mm	1.02 in 26 mm	0.99 in 25 mm	0.54 in 14 mm	1.00 in 25 mm	1.37 in 35 mm	1.03 in 26 mm	1.26 in 32 mm	0.94 in 24 mm	0.71 in 18 mm	11.33 in 288 mm
URAVAN	0.89 in 23 mm	0.70 in 18 mm	1.02 in 26 mm	1.02 in 26 mm	1.06 in 27 mm	0.50 in 13 mm	1.24 in 31 mm	1.31 in 33 mm	1.40 in 36 mm	1.49 in 38 mm	1.10 in 28 mm	0.91 in 23 mm	12.64 in 321 mm

Table 6. Average monthly maximum and minimum temperatures, and temperature extremes, for seven NWS sites in the vicinity of the MCGRNA.

SITE NAME

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
CASTLE VALLEY												
39.0 F	47.5 F	57.6 F	67.3 F	77.0 F	88.5 F	93.9 F	91.2 F	82.2 F	68.8 F	52.2 F	40.7 F	67.2 F
3.9 C	8.6 C	14.2 C	19.6 C	25.0 C	31.4 C	34.4 C	32.9 C	27.9 C	20.4 C	11.2 C	4.8 C	19.6 C
19.0 F	25.2 F	33.1 F	39.9 F	48.7 F	58.0 F	63.0 F	61.6 F	52.3 F	41.0 F	29.4 F	21.4 F	41.1 F
-7.2 C	-3.8 C	0.6 C	4.4 C	9.3 C	14.4 C	17.3 C	16.4 C	11.3 C	5.0 C	-1.4 C	-5.9 C	5.1 C
TEMPERATURE EXTREMES: 107 F/42 C HIGH; -14 F/-26 C LOW												
CASTLETON												
35.5 F	42.9 F	51.2 F	60.7 F	72.8 F	82.9 F	89.6 F	86.9 F	77.8 F	64.0 F	49.6 F	38.5 F	62.8 F
1.9 C	6.1 C	10.7 C	15.9 C	22.7 C	28.3 C	32.0 C	30.5 C	25.4 C	17.8 C	9.8 C	3.6 C	17.1 C
15.4 F	21.3 F	27.8 F	36.0 F	45.9 F	54.3 F	61.1 F	59.0 F	49.3 F	39.2 F	28.3 F	18.1 F	38.0 F
-9.2 C	-5.9 C	-2.3 C	2.2 C	7.7 C	12.4 C	16.2 C	15.0 C	9.6 C	4.0 C	-2.1 C	-7.7 C	3.3 C
TEMPERATURE EXTREMES: 99 F/37 C HIGH; -15 F/-26 C LOW												
LA SAL												
36.1 F	40.6 F	47.7 F	57.0 F	67.5 F	78.4 F	84.9 F	81.6 F	74.1 F	61.4 F	47.5 F	38.2 F	59.6 F
2.3 C	4.8 C	8.7 C	13.9 C	19.7 C	25.8 C	29.4 C	27.6 C	23.4 C	16.3 C	8.6 C	3.4 C	15.3 C
13.6 F	17.2 F	22.7 F	30.3 F	39.4 F	48.3 F	54.9 F	53.0 F	45.1 F	34.0 F	23.8 F	15.4 F	33.2 F
-10.2 C	-8.2 C	-5.2 C	-0.9 C	4.1 C	9.1 C	12.7 C	11.7 C	7.3 C	1.1 C	-4.6 C	-9.2 C	0.7 C
TEMPERATURE EXTREMES: 101 F/38 C HIGH; -16 F/-27 C LOW												
LA SAL 2 SE												
36.7 F	41.4 F	49.6 F	58.7 F	68.3 F	80.2 F	86.4 F	84.6 F	75.8 F	63.7 F	47.7 F	38.5 F	61.0 F
2.6 C	5.2 C	9.8 C	14.8 C	20.2 C	26.8 C	30.2 C	29.2 C	24.3 C	17.6 C	8.7 C	3.6 C	16.1 C
12.2 F	16.9 F	24.4 F	30.2 F	38.1 F	46.4 F	52.9 F	52.5 F	44.1 F	33.2 F	21.7 F	13.8 F	32.2 F
-11.0 C	-8.4 C	-4.2 C	-1.0 C	3.4 C	8.0 C	11.6 C	11.4 C	6.7 C	0.7 C	-5.7 C	-10.1 C	0.1 C
TEMPERATURE EXTREMES: 101 F/38 C HIGH; -25 F/-32 C LOW												

Table 6 (Continued). Average monthly maximum and minimum temperatures, and temperature extremes, for seven NWS sites in the vicinity of the MCGRNA.

SITE NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
MOAB													
	42.6 F	51.4 F	62.1 F	72.3 F	82.5 F	93.0 F	99.1 F	96.2 F	87.6 F	74.4 F	57.1 F	45.2 F	72.0 F
	5.9 C	10.8 C	16.7 C	22.4 C	28.1 C	33.9 C	37.3 C	35.7 C	30.9 C	23.6 C	13.9 C	7.3 C	22.2 C
	18.4 F	25.0 F	33.2 F	41.3 F	49.3 F	57.1 F	63.5 F	61.9 F	52.3 F	40.3 F	28.4 F	21.0 F	41.0 F
	-7.6 C	-3.9 C	0.7 C	5.2 C	9.6 C	13.9 C	17.5 C	16.6 C	11.3 C	4.6 C	-2.0 C	-6.1 C	5.0 C
TEMPERATURE EXTREMES: 114 F/46 C HIGH; -24 F/-31 C LOW													
GATEWAY													
	41.3 F	49.9 F	58.5 F	67.5 F	77.1 F	87.3 F	92.6 F	90.1 F	82.2 F	69.8 F	55.0 F	43.8 F	68.0 F
	5.2 C	9.9 C	14.7 C	19.7 C	25.1 C	30.7 C	33.7 C	32.3 C	27.9 C	21.0 C	12.8 C	6.6 C	20.0 C
	17.1 F	24.4 F	31.3 F	37.8 F	46.4 F	54.9 F	61.5 F	59.6 F	50.4 F	38.9 F	28.4 F	19.8 F	39.3 F
	-8.3 C	-4.2 C	-0.4 C	3.2 C	8.0 C	12.7 C	16.4 C	15.3 C	10.2 C	3.8 C	-2.0 C	-6.8 C	4.2 C
TEMPERATURE EXTREMES: 106 F/41 C HIGH; -28 F/-33 C LOW													
URAVAN													
	41.7 F	49.9 F	58.4 F	67.5 F	78.4 F	89.2 F	94.9 F	92.2 F	83.6 F	71.5 F	54.6 F	42.9 F	68.8 F
	5.4 C	9.9 C	14.7 C	19.7 C	25.8 C	31.8 C	34.9 C	33.4 C	28.7 C	21.9 C	12.6 C	6.1 C	20.4 C
	15.1 F	22.1 F	29.0 F	35.5 F	44.4 F	52.4 F	58.9 F	58.0 F	48.3 F	36.7 F	26.7 F	17.8 F	37.1 F
	-9.4 C	-5.5 C	-1.7 C	1.9 C	6.9 C	11.3 C	14.9 C	14.4 C	9.1 C	2.6 C	-2.9 C	-7.9 C	2.8 C
TEMPERATURE EXTREMES: 110 F/43 C HIGH; -23 F/-31 C LOW													

DESCRIPTION OF VALUES

Flora and Communities

Table 7 lists plant species in the MCGRNA. Scientific nomenclature follows Welsh et al. (1993), with some commonly-used synonyms included in Table 7 where appropriate. Nomenclature for trees agrees with Little (1979).

Table 7. Plant species in the Mill Creek Gorge Research Natural Area.

LIFE FORM *Scientific name*[1] [*Synonym*, if any] (common name)	Habitat/Plant community[2] A	B	C	D	E	F	G
TREES[3]							
Acer grandidentatum (bigtooth maple)		X	X				
Acer negundo (boxelder)	X	X					
Juniperus osteosperma (Utah juniper)			X			X	X
Juniperus scopulorum (Rocky Mountain juniper)				X			
Pinus edulis (two-needle piñon pine)		X	X	X		X	X
Populus angustifolia (narrowleaf cottonwood)	X	X					
Populus fremontii (Fremont cottonwood)		X					
Pseudotsuga menziesii (Douglas-fir)	X	X	X	X			
SHRUBS AND SUBSHRUBS							
Acer glabrum (Rocky Mountain maple)					X		
Alnus incana (thinleaf alder)	X						
Amelanchier alnifolia (serviceberry)	X	X	X				
Amelanchier utahensis (Utah serviceberry)			X	X	X		
Artemisia bigelovii (Bigelow sagebrush)						X	
Artemisia nova (black sagebrush)				X			
Artemisia tridentata ssp. *tridentata* (basin big sagebrush)		X					
Artemisia tridentata ssp. *vaseyana* (mountain big sagebrush)				X			
* *Berberis fendleri* (Fendler's barberry)	X						
Betula occidentalis (water birch)	X						
Brickellia californica (California brickellbush)						X	
Brickellia microphylla (rough brickellbush)						X	X
Cercocarpus intricatus (dwarf mountain mahogany)			X			X	X
Cercocarpus montanus (birchleaf mountain mahogany)			X	X			X
Chrysothamnus nauseosus (rubber rabbitbrush)	X	X				X	X
Chrysothamnus viscidiflorus (viscid rabbitbrush)				X		X	
Cornus sericea (red-osier dogwood)	X						
Ephedra viridis (green ephedra)			X			X	
Eriogonum corymbosum (corymbed buckwheat)						X	X
Eriogonum microthecum (slender buckwheat)				X			
Fendlerella utahensis (Utah fendlerella)				X			X
Fraxinus anomala (single-leaf ash)		X	X			X	
Gutierrezia microcephala (thread snakeweed)						X	
Holodiscus dumosus (mountain spray)							X
Mahonia fremontii (Fremont barberry)						X	
Mahonia repens [*Berberis repens*] (Oregon grape)				X			
Pachistima myrsinites (mountain lover)	X	X		X			
Peraphyllum ramosissimum (squaw apple)				X			
Prunus virginiana (chokecherry)		X	X	X	X		
Purshia mexicana [*Cowania mexicana*] (cliffrose)						X	
Purshia tridentata (bitterbrush)						X	X
Quercus gambelii (Gambel oak)	X	X	X	X	X		
Rhus aromatica var. *trilobata* (skunkbush)	X	X					

Table 7 (Continued). Plant species in the Mill Creek Gorge Research Natural Area.

LIFE FORM *Scientific name*[1] [*Synonym*, if any] (common name)	Habitat/Plant community[2] A	B	C	D	E	F	G
SHRUBS (CONTINUED)							
* *Ribes inerme* (whitestem gooseberry)		X					
Ribes montigenum (mountain gooseberry)					X		
Rosa woodsii (Woods rose)	X	X		X	X		
* *Salix bebbiana* (Bebb's willow)	X				X		
Salix exigua (coyote willow)	X				X		
Salix lutea (yellow willow)	X				X		
Sambucus caerulea (blue elderberry)		X					
Symphoricarpos longiflorus (long-flower snowberry)		X				X	
Symphoricarpos oreophilus (mountain snowberry)		X		X			
Tamarix chinensis (tamarisk)	X						
GRAMINOIDS							
Agrostis stolonifera (carpet bentgrass)					X		
Aristida arizonica (Arizona threeawn)						X	X
Bouteloua curtipendula (sideoats grama)						X	
Bromus inermis (smooth brome)	X			X	X		
Bromus tectorum (cheatgrass)	X	X				X	X
Carex microptera (small-wing sedge)	X				X		
Carex rossii (Ross' sedge)				X		X	
Dactylis glomerata (orchardgrass)				X			
Elymus elymoides [*Sitanion hystrix*] (squirreltail)				X		X	
Elymus salinus (Salina wildrye)						X	
Elymus smithii [*Agropyron smithii*] (western wheatgrass)				X			
Hilaria jamesii (galleta)						X	
Juncus arcticus [*Juncus balticus*] (Baltic rush)	X				X		
Juncus ensifolius (swordleaf rush)					X		
Juncus torreyi (Torrey's rush)					X		
Koeleria macrantha (junegrass)					X		X
Oryzopsis micrantha (littleseed ricegrass)							X
Phleum pratense (timothy)					X		
Poa bulbosa (bulbous bluegrass)		X					
Poa fendleriana (mutton grass)				X		X	X
Poa pratensis (Kentucky bluegrass)	X	X		X	X	X	
Puccinellia nuttalliana (Nuttall's alkaligrass)					X		
Sporobolus sp. (dropseed)		X				X	
Stipa comata (needle and thread)						X	
Stipa hymenoides [*Oryzopsis hymenoides*] (Indian ricegrass)				X		X	X
Stipa lettermanii (Letterman needlegrass)					X		
Stipa speciosa (desert needlegrass)						X	
FORBS AND SUCCULENTS							
Achillea millefolium (milfoil yarrow)				X	X		
Apocynum cannabinum (dogbane)	X						

Table 7 (Continued). Plant species in the Mill Creek Gorge Research Natural Area.

LIFE FORM *Scientific name*[1] [*Synonym*, if any] (common name)	Habitat/Plant community[2] A	B	C	D	E	F	G
FORBS AND SUCCULENTS (CONTINUED)							
Arenaria congesta (head sandwort)				X			
Artemisia dracunculus (tarragon)							X
Artemisia ludoviciana (Louisiana wormwood)	X	X		X		X	
* *Asclepias asperula* (spider milkweed)						X	
Aster chilensis (Pacific aster)					X		
Aster glaucodes (blueleaf aster)				X	X		
Astragalus lentiginosus var. *palans* (straggling milkvetch)						X	
Astragalus mollissimus (woolly locoweed)		X				X	
Astragalus tenellus (pulse milkvetch)				X			
Balsamorhiza sagittata (arrowleaf balsamroot)				X			
Calochortus nuttallii (sego lily)				X			
Cardamine cordifolia (heartleaf bittercress)	X						
Castilleja linariifolia (linearleaf paintbrush)				X			
* *Cirsium calcareum* var. *bipinnatum* (wingless thistle)	X				X		
Clematis ligusticifolia (white virgins-bower)	X						
Comandra umbellata (bastard toadflax)				X	X	X	
Cryptantha flavoculata (yellow-eye cryptanth)						X	
Descurainia pinnata (pinnate tansymustard)				X			
Echinocereus triglochidiatus (claretcup)						X	X
Epilobium ciliatum (northern willowherb)				X	X		
Equisetum hyemale (common scouring rush)	X						
* *Erigeron divergens* (spreading daisy)		X					
Erigeron eatonii (Eaton's daisy)				X			
* *Erigeron engelmannii* (Engelmann's daisy)						X	
Erigeron flagellaris (trailing daisy)				X			
Erigeron speciosus (Oregon daisy)				X			
Erigeron utahensis (Utah daisy)						X	
Eriogonum racemosum (redroot buckwheat)				X			
Galium multiflorum (shrubby bedstraw)						X	
Haplopappus armerioides (thrifty goldenweed)						X	
Hedysarum boreale (northern sweetvetch)	X						
Heterotheca villosa (hairy goldenaster)		X		X		X	X
Heuchera rubescens (red alumroot)					X		X
Iris missouriensis (Missouri iris)					X		
Lathyrus lanszwertii var. *leucanthus* (whiteflower sweetpea)				X			
Leptodactylon pungens (sharp slenderlobe)						X	X
Lotus wrightii (Wright's trefoil)						X	
Lupinus argenteus (silvery lupine)				X			
Melilotus officinalis (yellow sweetclover)	X				X		
Oenothera caespitosa (tufted evening primrose)						X	
* *Oenothera pallida* var. *pallida* (pale evening primrose)		X					
Opuntia erinacea (common pricklypear)						X	
Opuntia phaeacantha (berry pricklypear)		X				X	

Table 7 (Continued). Plant species in the Mill Creek Gorge Research Natural Area.

LIFE FORM *Scientific name*[1] [*Synonym*, if any] (common name)	Habitat/Plant community[2] A	B	C	D	E	F	G
FORBS AND SUCCULENTS (CONTINUED)							
Opuntia polyacantha (central pricklypear)		X		X		X	X
* *Penstemon crandallii* var. *atratus* (La Sal penstemon)				X			
* *Penstemon cyanocaulis* (bluestem penstemon)	X	X					
Penstemon eatonii (Eaton's penstemon)	X					X	
Petradoria pumila (rock goldenrod)				X			
Phlox sp. (phlox)						X	
Physaria newberryi (Newberry's twinpod)						X	
Plantago major (common plantain)					X		
Psilostrophe sparsiflora (greenstem paperflower)						X	
Ranunculus cymbalaria (marsh buttercup)					X		
Scrophularia lanceolata (figwort)	X						
Senecio integerrimus (gauge plant)						X	
Senecio multilobatus (Uinta groundsel)		X		X		X	
Smilacina racemosa (false solomon seal)		X					
Smilacina stellata (stellate smilacina)		X			X		
Solidago sparsiflora (alcove goldenrod)				X		X	
Sphaeralcea coccinea (common globemallow)		X					
Sphaeralcea parvifolia(?) (Nelson's globemallow)		X				X	
Stanleya pinnata (prince's plume)						X	X
Stephanomeria exigua (annual wirelettuce)						X	X
Streptanthus cordatus (twistflower)						X	
Swertia radiata [*Frasera speciosa*] (elkweed)				X			
Taraxacum officinale (common dandelion)				X	X		
Thalictrum fendleri (Fendler meadowrue)					X		
Thelypodium integrifolium (tall thelypody)		X					
Tragopogon dubius (salsify)	X				X		
Trifolium longipes (Rydberg's clover)					X		
Urtica dioica (stinging nettle)				X	X		
Vicia americana (American vetch)				X			
Viguiera multiflora (showy goldeneye)				X			
Viola adunca (blue violet)					X		
Yucca angustissima (narrowleaf yucca)						X	
Yucca baccata (datil yucca)						X	

NOTES:

1. Scientific nomenclature follows: Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgins, eds. 1993. A Utah flora, second edition. Brigham Young University, Provo, UT. 986 p.

Table 7 (Continued). Plant species in the Mill Creek Gorge Research Natural Area.

NOTES (Continued):

2. Habitats/Plant communities:
   A. *Betula-Acer* riparian woodland communities; bottom of gorge along Mill Creek.
   B. *Quercus-Rhus* communities; terraces adjacent to main riparian zone in bottom of gorge, lower-western end.
   C. *Pseudotsuga-Cercocarpus-Amelanchier* conifer/shrub communities; lower and middle north-facing slopes, below Entrada/Moab Member sandstone.
   D. *Quercus-Cercocarpus-Amelanchier* mountain brush communities; upper north-facing slopes, above Entrada/Moab Member sandstone in eastern part of area.
   E. Small seep and stream habitats within mountain brush; extreme southeastern corner of area.
   F. *Pinus-Juniperus* woodland communities; south-facing slopes.
   G. Sandstone outcrops on cliff faces, cliff rims, canyon sideslopes.

3. Nomenclature for trees follows: Little, E.L., Jr. 1979. Checklist of United States trees. USDA Forest Service Agricultural Handbook 541. 375 p.

* Collected and deposited in regional herbaria.

The MCGRNA contains no plants federally listed as endangered or threatened, nor any plants considered sensitive by Region Four of the USDA Forest Service. At one time *Penstemon crandallii* var. *atratus* (La Sal penstemon) was thought to be rare, but sufficient numbers and locations are now known for it so that it is not considered as sensitive. One interesting note is presence of the low-growing shrub *Berberis fendleri* (Fendler's barberry) in the riparian area near the lower end of the gorge. This shrub appears to be near the edge of its range in southeastern Utah, being more abundant to the east in Colorado and New Mexico.

Seven types of plant communities (defined by existing vegetation) or habitats (defined by abiotic features) were identified in the MCGRNA (see Table 7). Only the first of these appears to be treated in a comprehensive, regional vegetation classification system, and even then with some difficulty. These seven communities and habitats are described in more detail below. Geologic strata referenced in these descriptions are described more fully in the **Geology** subsection of this Record.

A. *Betula occidentalis-Acer negundo* (water birch-boxelder) riparian communities.

These communities occupy the immediate streamside riparian zone along Mill Creek essentially throughout the length of the RNA. They are comprised of several species of tall shrubs or low trees that form a dense woodland through which travel is tedious (Photos 3 and 4). The most abundant species in this mix are *Betula occidentalis* and *Acer negundo*, though the latter is more scarce at the lower end of the gorge. Other common shrubs include *Cornus sericea*, *Alnus incana* and, in the lower part of the gorge, *Salix exigua* and *Salix lutea*. These riparian communities also contain individuals or patches of *Quercus gambelii* and *Pseudotsuga menziesii* -- trees that are more abundant on adjacent canyon sideslopes but that also overhang or grow directly in streamside positions.

Understory vegetation is usually sparse in these communities, owing to the dense shading of ground surfaces by the overstory shrubs and trees. Common understory species include *Poa pratensis*, *Equisetum hyemale* and *Apocynum cannabinum*, plus exotics such as *Bromus inermis* and *Melilotus officinalis*.

Identification of these communities according to the classification of Padgett et al. (1989) is difficult, because species indicative of several of their community types grow intermingled in a complex mosaic. The most likely candidates for representation are the *Acer negundo/Cornus sericea*, *Betula occidentalis/ Cornus sericea*, *Betula occidentalis*/Mesic Forb, and *Betula occidentalis/Poa pratensis* community types.

B. *Quercus gambelii-Rhus aromatica* var. *trilobata* (Gambel oak-skunkbush) communities.

These communities occupy gently-sloping valleybottom terraces between the main riparian zone and steep canyon sideslopes, particularly in the lower-western half of the MCGRNA (Photo 4). They form patches or thickets of shrubs and low trees scattered among clearings occupied by herbaceous plants. The most abundant tree/shrub species are *Quercus gambelii* and *Rhus aromatica* var. *trilobata*. Other common woody species include *Chrysothamnus nauseosus*, *Rosa woodsii*, *Symphoricarpos oreophilus*, *Pachistima myrsinites*, *Prunus virginiana* and *Acer grandidentatum*. Toward the lower end of the gorge these communities also include the shrubs *Fraxinus anomala* and *Artemisia tridentata*.

Common herbaceous plants in the clearings between shrub patches include *Artemisia ludoviciana*, *Thelypodium integrifolium*, *Heterotheca villosa* and *Oenothera pallida*. Also present in these openings are locally-dense patches of the exotic grass *Bromus tectorum*.

C. *Pseudotsuga menziesii-Cercocarpus* spp.-*Amelanchier* spp. (Douglas fir-mountain mahogany-serviceberry) conifer/shrub communities.

Lower and middle north-facing sideslopes of the gorge, mostly in its eastern half and mostly below the Entrada/Moab Member sandstone layer, are generally occupied with vegetation of this type (Photo 7). It consists of scattered individuals to small patches of *Pseudotsuga menziesii*, accompanied in most locations by *Pinus edulis* and *Juniperus osteosperma*. Beneath and among these conifers are patchy to moderately-dense tall shrubs, mostly *Cercocarpus montanus*, *Cercocarpus intricatus*, *Amelanchier* spp. (*A. alnifolia* and/or *A. utahensis)*, *Quercus gambelii*, *Fraxinus anomala* and *Prunus virginiana*.

The *Pseudotsuga* tends to be most dense in concave swales on the sideslopes, forming small closed-canopy patches in such locations; the *Quercus* and *Amelanchier* shrubs are likewise more dense in these concave positions. Sites between the side drainages tend to be less densely vegetated, and contain relatively more of the *Pinus* and *Juniperus*. These latter sites were also seen to support appreciable coverage of bunchgrasses. Individual grass species were not identified, however, because these sites were all seen from a distance during field inventories of the MCGRNA.

These communities contain elements of both the mountain brush and piñon-juniper vegetation types (letters D and F below). In fact, many locations shown on Map 5 as the piñon-juniper cover type on the south side of the gorge belong to this vegetation unit. The presence of *Pseudotsuga* is likely due to the cool/moist nature of these sites, given that they are: (a) on steep, north-facing slopes, and (b) within the gorge where cool air drains down from the mountains above. The composition and other features of these stands, only a few of which appear to represent "forest" sites, do not match well with any of the *Pseudotsuga menziesii* habitat types described by Youngblood and Mauk (1985).

D. *Quercus gambelii-Cercocarpus montanus-Amelanchier utahensis* (Gambel oak-birchleaf mountain mahogany-Utah serviceberry) mountain brush communities.

These communities occupy north-facing slopes mostly above the Entrada/Moab Member sandstone layer in the upper-southeastern part of the MCGRNA (Photo 5). They consist of moderately- to (most often) very-dense stands of tall shrubs, in which *Quercus gambelii, Amelanchier utahensis* and *Cercocarpus montanus* are the most abundant species (Photo 6). Beneath the tall-shrub canopy are lower shrubs such as *Symphoricarpos oreophilus*, *Chrysothamnus viscidiflorus*, *Prunus virginiana* and *Rosa woodsii*. Within and above the shrub matrix are scattered individuals of *Pseudotsuga menziesii* and *Pinus edulis*.

Occasional small clearings within the shrubs support a rich mix of herbaceous species. *Poa fendleriana*, *Carex rossii* and *Stipa hymenoides* are among the more abundant graminoids. Common forbs include *Astragalus tenellus*, *Artemisia ludoviciana*, *Balsamorhiza sagittata*, *Castilleja linariifolia*, *Eriogonum racemosum*, *Heterotheca villosa*, *Petradoria pumila*, *Senecio multilobatus* and *Viguiera multiflora*.

This vegetation type does not appear to be included in any comprehensive, regional vegetation classification treatment. However, it is known to be an extensive type at middle elevations of the La Sal and Abajo Mountains and on the Tavaputs Plateau of southeastern Utah, positioned above the piñon-juniper zone and below the aspen-Douglas fir zone. Cronquist et al. (1972) would include this vegetation type within their broad "Chaparral Zone" of the Wasatch montane vegetation series, even though their description (page 143) tends to include more riparian and moist-site species than are present in the terrestrial mountain brush vegetation of the MCGRNA.

E. Small seep and stream habitats within mountain brush.

These are distinct but very localized habitats located in a draw within the general mountain brush vegetation (letter D above) in the southeastern corner of the MCGRNA. A hillside seep/spring area feeds a very small rivulet stream that flows down to and over the Entrada/Moab Member sandstone. Shrubs typical of the mountain brush type (such as *Quercus gambelii* and *Amelanchier utahensis*) generally overtop these small wet sites, but species indicative of the additional soil moisture are also present. These include three willow species: *Salix exigua, Salix lutea* and *Salix bebbiana*. Graminoids present include *Agrostis stolonifera*, *Carex microptera*, several *Juncus* spp., and *Puccinellia nuttalliana*. Moist-site forbs found in these habitats include *Aster chilensis*, *Epilobium ciliatum*, *Ranunculus cymbalaria*, *Smilacina stellata* and *Thalictrum fendleri*. These habitats also contain a number of exotic species, including *Bromus inermis*, *Phleum pratense*, *Melilotus officinalis* and *taraxacum officinale*.

F. *Pinus edulis-Juniperus osteosperma* (two-needle piñon pine-Utah juniper) woodland communities.

This is the dominant type of vegetation growing on virtually all of the steep south-facing slopes on the north side of Mill Creek, from the lower-western end to the upper-eastern end of the MCGRNA. It consists of woodlands of *Pinus edulis* and *Juniperus osteosperma*, varying from rather sparse cover of these two trees at lower elevations of the area, to more dense woodlands at higher, eastern sites (Photo 8).

Two of the most conspicuous associated species are *Ephedra viridis* and *Yucca baccata*. Other common shrubs include *Artemisia bigelovii*, *Chrysothamnus nauseosus*, *Chrysothamnus viscidiflorus*, *Fraxinus anomala* and *Symphoricarpos longiflorus*. A number of grasses are common throughout this type, the most abundant of which appear to be *Poa fendleriana* and *Stipa comata*. Also present in many sites of this type are *Elymus salinus*, *Stipa hymenoides* and *Hilaria jamesii*. These communities also support a fairly rich mix of forbs and cacti, with common species including *Astragalus mollissimus*,

Echinocereus triglochidiatus, *Haplopappus armerioides*, *Heterotheca villosa*, *Opuntia* spp., *Penstemon eatonii*, *Senecio multilobatus*, *Stanleya pinnata* and *streptanthus cordatus*.

As mentioned above under letter C, the south (north-facing) slopes of the gorge, particularly toward its lower western end, support communities with considerable amounts of piñon and juniper trees. These woodlands differ from those on the north side of the gorge (described in the two preceeding paragraphs) in that they contain an appreciable complement of mesic tall shrubs such as *Quercus*, *Cercocarpus* and *Amelanchier* spp. These south-side woodlands thus appear to be transitional between purer, more xeric piñon-juniper woodlands of the north side of the gorge, and purer mountain brush stands in the higher southeastern part of the MCGRNA.

Though the woodlands of two-needle piñon pine and Utah juniper in the MCGRNA are not specifically identified in any comprehensive regional classification, they represent a segment of the great diversity within the general piñon-juniper zone that occupies large expanses of land in the Intermountain region (Cronquist et al., 1972; p. 126).

G. Sandstone outcrops on cliff faces, cliff rims, and canyon sideslopes.

These are habitats comprised mostly of bare rock (i.e. with little or no soil development) located throughout the MCGRNA. They consist of cliff faces, upper rims of cliff bands, and other steep slickrock exposures formed by the Navajo Sandstone, Entrada/Slickrock Member, and Entrada/Moab Member (all Photos except #6).

Vegetation is typically sparse on these rock outcrops. Many of the plants that do cling to these exposures are species found in adjacent vegetation communities. However, a few species are more or less confined to these habitats within the RNA, such as *Cercocarpus intricatus*, *Holodiscus dumosus*, *Brickellia microphylla* and *Leptodactylon pungens*.

Areas of rock outcrop are treated as unmapped inclusions within the vegetation types (mostly piñon-juniper) delineated on Map 5. Although expansive bare-rock surfaces are visually apparent within the MCGRNA, most of these are very steep or vertical and thus do not translate to a large (or easily mappable) aggregate area as defined by their horizontal projection.

Fauna

Appropriate habitat exists in the MCGRNA for three wildlife species found on the former Moab Ranger District that are listed as Endangered or Threatened: the southwestern willow flycatcher (*Empidonax traillii extimus*), peregrine falcon (*Falco peregrinus*) and Mexican spotted owl (*Strix occidentalis lucida*). However, none of these three have yet been documented to occur within the RNA.

The southwestern willow flycatcher could occur in the bottom of the gorge along Mill Creek, although these birds generally prefer calm, still water rather than swiftly running streams. Locations in the MCGRNA where waters pool and willows are present may support these flycatchers.

Peregrine falcons prefer steep cliffs with developed riparian vegetation and associated songbirds below. This type of habitat does exist in the MCGRNA. However, optimum habitat for peregrine falcons is believed to be wider, more open gorges and canyons with well-developed riparian areas in the bottoms. The gorge of Mill Creek may be too narrow and lack sufficient riparian community development to be considered as optimum habitat for peregrine falcons.

Mexican spotted owls in southeastern Utah have been associated with tall sheer cliffs containing cracks, and with ponderosa pine trees at the base of the cliffs. The Mill Creek Gorge was surveyed for

Mexican spotted owls in 1990-91, but none were located. Although a few large conifer trees occur in the bottom of the gorge, there may not be enough of them to provide optimum habitat for Mexican spotted owls.

Several wildlife species considered Sensitive by Region Four of the USDA Forest Service may be present in the MCGRNA. The Flammulated owl (*Otus flammeolus*), Three-toed woodpecker (*Picoides tridactylus*) and Northern goshawk (*Accipiter gentilis*) generally occupy mixed forests of spruce, fir, pine and/or aspen on the former Moab Ranger District. These birds may occur toward the eastern end of the MCGRNA, along the bottom of the gorge where conifer trees exist. The limiting factor for these three bird species may be available prey within the gorge. The spotted bat (*Euderma maculatum*) is known to occupy a variety of vegetation types, but is generally associated with water sources and high cliffs. These features are present in the MCGRNA, and the area provides appropriate if not optimum habitat for the spotted bat. Townsend's big-eared bat (*Corynorhinus townsendi*) has been known to occupy a variety of vegetation types and may even use tree cavities for daytime roosting. Their roosting is most often associated with mine shafts, caves and rock outcrops. Appropriate habitat for Townsend's big-eared bat does exist in and around the MCGRNA.

The MCGRNA supports several species identified as Management Indicator Species (MIS) in the Forest Plan (USDA Forest Service 1986b; page II-31), including Rocky Mountain mule deer (*Odocoileus hemionus*), Blue grouse (*Dendragapus obscurus*), Golden eagle (*Aquila chrysaetos*), and aquatic macroinvertebrates.

Rocky Mountain mule deer occur within the MCGRNA, though they likely come into the area from the bottom (west) since the area's high cliffs would hinder their coming in from above. The Utah Division of Wildlife Resources considers the mouth of Mill Creek Gorge to be high value winter/transitional range for deer.

Blue grouse may be present within the shrub and tree vegetation types within the MCGRNA. The gorge is accessible and suitable for blue grouse, given their preference for mixed-conifer and/or oakbrush stands near water and their ability to fly.

The MCGRNA would likely be considered as optimum habitat for golden eagles. The various types of trees in the area may be used as perch and nest sites while eagles forage for rabbits and rodents in grassy openings above the gorge.

Macroinvertebrates inhabit Mill Creek through the gorge. Results of macroinvertebrate sampling in Mill Creek above the crossing of the Loop Road show a healthy biotic condition, with 100% of the sampling sites being above the Forest Plan standard. The Diversity Index for macroinvertebrates showed that 80% of the samples were at or above Forest Plan standards.

Other wildlife species of interest that are likely to occur in the MCGRNA are mountain lion (*Felis concolor*) and black bear (*Ursus americanus*). Mountain lions may occupy the gorge, as they can climb down crevices and ledgy areas in the cliffs for water and/or food. However, since deer are a major part of their diet, limited prey availability may limit use of the gorge by mountain lions. Black bear are known to use at least portions of the MCGRNA as part of their ranges. Signs of black bears were seen in mountain brush communities in the upper-southeastern part of the MCGRNA during a 1997 RNA field inspection trip there.

An abbreviated list of other animals likely to be present in the MCGRNA is presented at the top of the next page.

BIRDS	
Yellow-green vireo	*Vireo flavoviridis*
Rock wren	*Salpinctes obsoletus*
White-throated swift	*Aeronautes saxatalis*
Dark-eyed junco	*Junco hyemalis*
Hermit thrush	*Catharus guttatus*
Cooper's hawk	*Accipiter cooperii*
Broad-tailed hummingbird	*Selasphorus platycercus*
Yellow warbler	*Dendroica petechia*
MAMMALS	
Big brown bat	*Eptesicus fuscus*
Pallid bat	*Antrozous pallidus*
Least chipmunk	*Eutamias minimus*
Rock squirrel	*Spermophilus variegatus*
Northern pocket gopher	*Thomomys talpoides*
Bushy-tailed woodrat	*Neotoma cinerea*
Ringtail	*Bassariscus astutus*
Stiped skunk	*Mephitis mephitis*
Bobcat	*Lynx rufus*
REPTILES	
Ringneck snake	*Diadophis punctatus*
Western terrestrial garter snake	*Thamnophis elegans*
Western fence lizard	*Sceloporus occidentalis*
Side-blotched lizard	*Uta stansburiana*

Geology

The geologic events that formed and shaped the present-day La Sal Mountains and their surroundings are intertwined with the long-term history of the entire Colorado Plateau. Following is a brief synopsis of this geologic history, mostly summarized from Barnes (1993).

From the late Precambrian Era to the late Cretaceous Period, an interval of more than half a billion years, the incipient Colorado Plateau was a low-lying, relatively flat area. The region fluctuated many times between being inundated by shallow seas and being low coastal plains with little relief. The climate varied from tropical to subtropical, humid to arid. Many layers of marine, coastal, fresh-water and aeolian deposits accumulated during this time. This thick crust of sediments largely protected the region from the effects of major tectonic events that were to follow.

The first such event was an eastward-traveling crustal pressure that began in late Cretaceous time and lasted well into the Tertiary Period. Within the incipient Colorado Plateau, this pressure produced several uplifts (Circle Cliffs, San Rafael Swell) and basins (Uinta, Kaiparowits). The region was still not far above sea level, and had few elevational extremes. Gentle topography and arid climate combined to place limits on the effectiveness of water erosion processes.

A period of volcanism began in the region toward the end of the Eocene Epoch. This activity was most widespread and intense around the perimeter of the Colorado Plateau during the Oligocene and early Miocene Epochs. The thick sedimentary crust prevented significant extrusive activity within the Colorado Plateau itself. However, magma did flow upward and intrude subsurface sedimentary strata at several locations, one of which became the La Sal Mountains.

About 24 million years ago, in early Miocene time, the roots of the present-day La Sal Mountains were formed by three closely-spaced vertical upwellings of magma, termed stocks. Magma from the stocks flowed horizontally into incompetent or weak sedimentary strata, primarily mudstones and shales. These horizontal intrusions formed a series of laccoliths radiating outward from each central stock, bulging overlying sedimentary strata upward into domes. These subsurface igneous intrusions were superimposed on an existing set of northwest-southeast-trending salt-anticline structural features in the region (Hunt 1958).

Following the emplacement of these igneous intrusions, the land's surface was probably one of high, rounded hills. Erosion continued at a very slow rate through the remainder of the Miocene Epoch, except on the domes above the igneous intrusions where greater vertical relief increased erosion somewhat. [The general westward slope of the terrain surrounding Mill Creek Gorge (South Mesa, Brumley Ridge) is therefore attributable to the bulging of pre-existing sedimentary layers caused by igneous intrusions that formed the La Sal Mountains.]

The proto-La Sals remained as rounded highlands until a major regionwide uplift event began about 10 million years ago, in the early Pliocene Epoch. This event raised the entire Colorado Plateau more than a mile higher than it had been. As the region became higher its climate became wetter, especially in the highlands above the igneous intrusions. This greatly accelerated the effectiveness and rate of water erosion throughout the region, resulting in the labyrinth of canyons -- such as Mill Creek Gorge itself -- for which the Colorado Plateau is famous. Also in relatively recent times, salt bodies underlying the linear anticlines of the region were largely eroded out. This caused these features to collapse and form the series of northwest-southeast trending valleys that are so prominent in the region, among which Spanish Valley is closest to the MCGRNA.

Hintze and Stokes (1964) provide a general, small-scale geologic map of the region in which the MCGRNA lies. A much more detailed geologic map for the country immediately north of the MCGRNA has been done by Doelling (1993). Although the area of the MCGRNA does not appear on this 1993 map, it is close enough to allow identification of the stratigraphy of the RNA via extrapolation. The geologic strata of the MCGRNA, all of which date from the Jurassic Period, are therefore described as follows.

The uppermost, youngest stratum of the MCGRNA is the Salt Wash Member of the Morrison Formation. This layer forms the highest-elevation slopes and low cliff bands on both sides of the gorge in about the easternmost mile of the RNA. It appears as the short upper cliff band and subtending slopes in Photo 8. The Salt Wash Member is comprised of light yellow-gray sandstone interbedded with red and gray mudstone and siltstone. The less-resistant mudstones and siltstones form slopes or recesses between the harder sandstone ledges. The Morrison/Salt Wash stratum is one of the major uranium-bearing strata on the Colorado Plateau, and there is evidence of past mineral exploration in these rocks near the boundaries of the MCGRNA.

At the base of the Morrison/Salt Wash Member is the Tidwell Member of the Morrison Formation. The Tidwell consists of lavender, maroon, red or light-gray siltstone and silty sandstone interbedded with light-gray sandstone and gray limestone. It is quite thin and is often covered with colluvial debris from the overlying Salt Wash Member. However, where it is exposed, the Tidwell Member is an excellent "red marker" along the top of the Entrada/Moab Member sandstone cliffs (see next paragraph).

Below the members of the Morrison Formation is the upper (and shorter) of two prominent cliff lines in the MCGRNA. This is the Moab Member of the Entrada Sandstone, comprised of light yellow-gray to pinkish-tan sandstone -- though in the RNA much of it appears darker due to coatings of desert varnish or black streaks from water flow of rain or snowmelt runoff. In about the upper mile of the MCGRNA, the Moab Member is the only high sandstone cliff above Mill Creek (Photos 2, 5 and 8) -- and is also the layer subject to rock climbing at the Loop Road crossing. In about the lower ⅓ to ½ of the RNA, the Moab

Member forms the upper rim of the gorge (Photos 1 and 7), where it serves as a well-defined boundary for the area.

Underlying the Moab Member through virtually the entire length of the MCGRNA is the thicker Slickrock Member of the Entrada Sandstone. The Slickrock Member is mostly orange-red aeolian sandstone with some white banding. It uniformly forms more of a steep slope than a nearly-vertical cliff, so that (within the MCGRNA at least) much of it is covered with colluvial debris from the overlying Moab Member cliffs (Photos 1 and 7). At the base of the Entrada/Slickrock Member is a band of dark red muddy sandstone, commonly displaying contorted "lumpy" bedding, that is assignable to the Dewey Bridge Member of the Entrada Sandstone. Within the MCGRNA the Dewey Bridge layer is very thin, and usually masked by colluvial material from overlying sandstone cliffs.

Below the members of the Entrada Formation is the lower (and taller) of the two prominent cliff lines in the MCGRNA. This is the Navajo Sandstone, comprised of light-hued (yellowish-tan) aeolian sandstone, though again with darker surface coatings in many locations. In about the lower ⅔ of the RNA, the Navajo Sandstone forms a distinct lower or "inner" gorge beneath the slopes of the Entrada/ Slickrock Member (Photos 1 and 7).

Underlying the Navajo Sandstone is the lowest, oldest stratum exposed in the MCGRNA. This is the Kayenta Formation, comprised primarily of reddish-brown to lavender-gray sandstone but also containing local white and dark-brown beds, intraformational conglomerate and limestone. The Kayenta forms a series of thick ledges alternating with less-resistant short slopes.

Soils

Soils of the area that includes Mill Creek Gorge have been mapped and described by the USDA Soil Conservation Service (1991). The MCGRNA includes portions of five soil mapping units, which are described below generally in order from highest to lowest elevation.

Mapping Unit 27: Falcon-Bond-Rock Outcrop Complex, 15 to 70 percent slopes. This unit occurs in the eastern half of the MCGRNA, on the uppermost (highest-elevation) slopes on both sides of gorge. These positions generally correspond with substrates derived from the Morrison Formation (Salt Wash and Tidwell Members); they support piñon-juniper woodlands on south-facing slopes, and mountain brush vegetation (oak-mahogany-serviceberry) on north-facing slopes. Thirty-five percent of this unit is Falcon gravelly-sandy loam, 25 to 65 percent slopes. Falcon soils are shallow and well-drained, and are formed in residuum derived predominantly from sandstone. Twenty-five percent of this unit is Bond loam, 15 to 70 percent slopes. Bond soils are shallow and well drained, and are also formed in residuum derived predominantly from sandstone. Twenty percent of this unit is rock outcrop, and the remaining twenty percent of the unit consists of other soils.

Mapping Unit 99: Ustic Torriorthents-Lithic Torriorthents, warm-Rock Outcrop Complex, 10 to 80 percent slopes. This unit occurs in the bottom of the gorge and on adjacent lower sideslopes in the easternmost part of the MCGRNA, and is laterally contiguous onto middle/upper-elevation sideslopes (above Unit 72, described next) in the central and western parts of area. These locations appear to correspond largely with substrates derived from the Entrada Formation (Moab and Slickrock Members); they support piñon-juniper woodlands on south-facing slopes, and piñon-juniper-Douglas fir-mountain brush vegetation on north-facing slopes. Thirty-five percent of this unit is Ustic Torriorthents, 10 to 80 percent slopes, on north-facing sideslopes and talus-cone footslopes. The Ustic Torriorthent soils are moderately deep to very deep and well drained, and are formed in colluvium derived predominantly from sandstone. Twenty-five percent of this unit is Lithic Torriorthents, warm, 30 to 50 percent slopes, on south- and west-facing sideslopes and narrow ledges. The Lithic Torriorthent soils are shallow and well drained, and are formed in residuum and colluvium also derived predominantly from sandstone. Twenty

percent of this unit is rock outcrop, and the remaining twenty percent of the unit consists of other soils and miscellaneous areas.

Mapping Unit 72: Rock Outcrop. This unit occurs in the bottom of the gorge and on adjacent lower sideslopes (both sides) from just inside the National Forest boundary eastward for about 2 miles (3.2 km). These locations appear to correspond largely with cliffs and other outcrops of the Navajo Sandstone. Ninety percent of this unit consists of areas of barren rock, with small areas of rubble land and shallow soils. Observations of areas in this mapping unit within the MCGRNA indicate a much lower percentage of bare rock outcrop, and greater percentage of colluvium-mantled slopes that support sparse piñon-juniper stands on south-facing aspects, and somewhat denser piñon-juniper/brush communities on north-facing aspects.

Mapping Unit 74: Rock Outcrop-Rizno Complex, 3 to 15 percent slopes. This unit occurs in the bottom of the gorge, but is present within the MCGRNA for less than ¼ mile (0.4 km) eastward from the National Forest boundary. Seventy percent of this unit is Rock outcrop. Twenty percent is Rizno fine sandy loam, 3 to 15 percent slopes. Rizno soils are shallow and well drained, and are formed in aeolian deposits over residuum derived predominantly from sandstone. Ten percent of this unit consists of other soils.

Mapping Unit 51: Mido loamy fine sand, dry, 2 to 8 percent slopes. This unit also occurs in the bottom of the gorge in the westernmost ¼ mile (0.4 km) or less of the MCGRNA. Mido soils are very deep and well drained, and are formed in sandy aeolian deposits derived predominantly from sandstone.

The soil survey document (USDA Soil Conservation Service 1991) provides additional information about the properties, management and suggested uses of the above-described soils that are present within the MCGRNA.

Lands

The Mill Creek Gorge RNA is entirely reserved National Forest System land with no encumbrances or withdrawals.

Cultural

The general region of Mill Creek Gorge contains evidence of occupancy by prehistoric people and later by Ute/Paiute Indians. No cultural resource surveys have been done in the MCGRNA, however. Based on its character and features, the MCGRNA is expected to contain very few prehistoric or historic cultural resources.

Other

The Mill Creek Gorge RNA contains no other known features of local (or wider) importance.

IMPACTS AND POSSIBLE CONFLICTS

Mineral Resources

Impacts and possible conflicts with respect to several major categories of mineral resources are each addressed in their own subsection below.

Leasable Minerals: oil and gas, coal, oil-impregnated rocks, and geothermal resources.

The general area of Mill Creek Gorge has a moderate potential for the presence of oil and gas resources. According to Gloyn et al. (1995), it is in a part of San Juan County underlain by several oil reservoirs that have the potential to become productive: the Cane Creek Shale Play and Paradox Play of the Pennsylvanian Paradox Formation, the Mississippian Leadville Limestone, and the McCracken Sandstone of the Devonian Elbert Formation.

Neither Gloyn et al. (1995) nor Clem and Brown (1984) show any existing oil or gas fields near the MCGRNA. The latter authors also show no occurrences of oil and gas or any drilling activity in T26S R23E, T27S R23E, T26S R24E, or T27S R24E; the closest drilling activity to the MCGRNA is located about 5 miles (8 km) to the southeast.

Information on oil and gas leases in this region is maintained by the Bureau of Land Management (BLM). The oil and gas leasing plats for T26S R23E (dated 1/29/98), T27S R23E (dated 6/2/98), T26S R24E (dated 3/21/94), and T27S R24E (dated 11/30/95) show that two leasing tracts overlap small portions of the MCGRNA, in Section 1 of T27S R23E and in Section 6 of T27S R24E. Both of these tracts are labeled "OG COMP" as of the dates of their respective plats. The plats show no identified oil/gas leasing tracts in the remaining sections that cover the MCGRNA.

The boundary of the MCGRNA appears to correspond closely with an area that is open to leasing with the stipulation of No Surface Occupancy (NSO) due to resource considerations, as established by the oil and gas leasing Environmental Impact Statement for the Forest (USDA Forest Service 1993b). Also, Forest-wide stipulations as provided in the Forest Plan (USDA Forest Service 1986b) state that slopes greater than 35% are not permissible for surface occupancy. Small portions of the MCGRNA that may be located outside the EIS-dictated NSO zone are largely steeper than 35% gradient, and thus would also be subject to the NSO stipulation.

Gloyn et al. (1995) report that the area surrounding Mill Creek Gorge contains no known or potential coal resources, oil-impregnated rocks or geothermal resources.

BLM records show no coal or geothermal leasing plats for the four Townships that overlap the MCGRNA, so it is assumed that no leases of these types exist in or anywhere near the area.

Locatable Minerals: Uranium-vanadium and metallic resources.

Elevatorski (1978) shows that Mill Creek Gorge is located in the Moab uranium/vanadium mining district. In 1909, uranium-vanadium mineralization was discovered above the south rim of Mill Creek Gorge, in the NW¼ of Section 1, T27S R23E. Later prospects were located along the margin of the gorge farther upstream: Sure Fire #3 on the north side of the gorge (Section 31, T26S R24E) and Horse Creek on the south side (Section 6, T27S R24E). The boundary of the RNA avoids areas of significant surface disturbance associated with these old prospecting locations.

Examination of prospects and waste dumps along Mill Creek by Forest minerals staff people results in assigning a low potential for profitable production of uranium, and moderate potential for vanadium, in the MCGRNA. None of the prospects seen were very deep, and the waste rock dumps were notably absent of either uranium or vanadium mineralization. Good occurrences of vanadium were seen about 2 miles (3.2 km) south of Mill Creek, but no historical evidence of vanadium production from them has been found.

In this portion of the Moab mining district, centered on Brumley Ridge, ore bodies occur in sandstones of the Salt Wash Member of the Morrison Formation, which forms the uppermost stratum

exposed in the MCGRNA. Specifically, the ore bodies are most often located at the basal contact of the Salt Wash sandstone cap. This means that potential ore-bearing rocks are gone from most of the MCGRNA (since Mill Creek has eroded through the sandstone cap, thus removing any ore), except in the upper eastern end of the area on both sides of the gorge. In these locations, where the basal sandstone contact containing potential ore deposits remains exposed, the most obvious surface access to the ore would be from within the RNA itself. Thus, disturbance associated with access to ore bodies would be the main concern with respect to mineral-related conflicts in the MCGRNA. Exploration drilling, and mine development, could be achieved without entering the boundary of the RNA. The use of declines instead of on-contact adits can allow access from above, off of the RNA.

In addition to paucity of uranium mineralization at prospects along Mill Creek, the current low spot prices for uranium further decrease the likelihood of production of uranium in the MCGRNA. No upward trend in uranium prices is foreseen in the short term future, given the present worldwide oversupply. Gloyn et al. (1995) write that at a market price of $10 per pound of concentrate, uranium requirements of U.S. utilities are now being met by low-cost (solution mining) domestic producers and foreign imports. They note that much higher prices for uranium and vanadium will be required before the uranium-vanadium mining industry in San Juan County is again viable. Chenoweth (1990) estimates that a price of $20 to $30 per pound U_3O_8 would be required.

With respect to metallic resources, Gloyn et al. (1995) report that occurrences of gold, copper and manganese in San Juan County have proved to be small and uneconomic (except for copper deposits along the Lisbon Valley fault, well away from the MCGRNA). They further write that lead, zinc, copper, molybdenum and several other metals are found associated with sedimentary-hosted uranium-vanadium deposits, but (with the exception of copper) all of these metals occur in quantities too small to be considered even as by-products of uranium-vanadium mining. Plate 8 of Gloyn et al. (1995) shows the extreme eastern end of the MCGRNA overlapped by an area with potential for gold associated with distal or proximal skarn, intrusive breccia, or stockwork deposits. However, they note that this potential is highly speculative, and based on occurrences of such deposits around similar intrusive bodies in Montana and Colorado. They conclude that in view of the limited number of gold occurrences, both lode and placer in these areas, that the potential must be ranked as low.

Information on mining claims for locatable minerals is maintained by the BLM. The number and status of mining claims in the sections that overlap the MCGRNA are shown below, according to BLM geographic index microfiche dated 5/18/98. All of these claims are lapsed or no longer active; that is, all are shown as "Case Closed" in the microfiche file. It is possible, however, for claims to exist without being shown in the BLM records.

Township/Range, Section	Lapsed Claims	Active Claims
T26S R23E, Section 35	2	0
T26S R23E, Section 36	2	0
T27S R23E, Section 1	0	0
T27S R23E, Section 2	0	0
T26S R24E, Section 31	25	0
T27S R24E, Section 6	4	0

Industrial Rock and Mineral Resources.

Text and plates in Gloyn et al. (1995) show the area of the MCGRNA to have little or no value for presence of industrial rock and mineral resources such as sand and gravel, bentonite, limestone, gemstones, ornamental stone, building stone, gypsum, humate, and others. Saline resources such as potash and salt are present in the Paradox Formation beneath much of San Juan County, but at Mill

Creek Gorge they are buried beneath more than 4000 feet (1220 m) of overburden, greatly diminishing the potential for their development.

Grazing

Mill Creek Gorge is located within the Brumley Ridge cattle allotment. Permitted use on the entire allotment is 368 cow-calf pairs from June 16 to October 19, for a total of 1668 head-months. More specifically, the MCGRNA lies in the Mill Creek unit of the allotment, which is managed under a rest-deferred five-pasture grazing system with a six-year rotation. This unit is normally scheduled to be grazed until proper use is reached.

The MCGRNA lies in a part of the Brumley Ridge allotment that is not purposely grazed or used for trailing, because of its steep, rugged terrain. Thus the RNA receives infrequent incidental grazing use from elsewhere on the allotment. The majority of such incidental use probably occurs in the southeastern portion of the area, where cattle may occasionally wander down onto the brushy slopes from gentler terrain to the south. Until recently, cattle could wander up into the bottom of the gorge from private land to the west of the National Forest boundary. The current owners of the land immediately below the Forest boundary, however, are adverse to the presence of cattle on their property. This attitude, coupled with changes made in trailing patterns between the Brumley Ridge allotment and the permittee's winter range, greatly diminishes the likelihood of incidental cattle movement into the MCGRNA from below to the west.

The Forest considers the vegetation of the MCGRNA to be either unsuitable range for cattle grazing or secondary range, and AUMs (carrying capacity) have not been allocated for the area. Therefore, designation of the MCGRNA would result in no reduction in cattle numbers or adjustments to the term grazing permit on the Brumley Ridge allotment.

The Forest has no plans for water developments or other range improvements within the area of the MCGRNA, and thus there will be no effort to move cattle into the area purposely. There are no existing fences in the RNA, none are needed, and no change in management is necessary in lieu of fencing. Livestock grazing will not be used as a management tool to maintain vegetation communities in the MCGRNA. Maintenance of the current grazing situation on the Brumley Ridge allotment will result in an acceptable level of casual or incidental livestock use that can be tolerated within the MCGRNA.

Given the situation and conditions described above, establishment of the MCGRNA poses no conflicts with grazing management on the Brumley Ridge cattle allotment.

Timber

The total forested area of the MCGRNA is about 75 acres (30 ha), considering that the most of the area is occupied by "non-forest" piñon-juniper woodlands and tall-shrub communities. The RNA is not included in those areas designated by the Forest Plan (USDA Forest Service 1986b) to be managed under the timber emphasis prescription (TBR), nor would the RNA's forest land be considered as available, capable or suitable for timber management under the Forest Plan. Productivity of the area's forest stands is generally less than 20 ft^3/acre/year (1.4 m^3/ha/yr). Access is very limited into the deep, steep-walled gorge, with no potential commercial use of the trees present in the MCGRNA. Designation of the MCGRNA would not affect (i.e. would withdraw no values from) the current timber management base as defined by the Forest Plan.

Watershed Values

The MCGRNA surrounds Mill Creek, a perennial stream that heads in the La Sal Mountains, descends rapidly through the RNA, and then flows through much drier country before joining the Colorado

river just west of Moab. Within the RNA, Mill Creek supports narrow bands of riparian habitat along its margins. The area may also contain some unmapped springs or seep areas. In general, the MCGRNA helps to maintain a flow of high-quality water to downstream users. RNA designation should have no impact on the watershed properties of this area.

Recreation Values

Recreational use of the MCGRNA is limited by its relative remoteness and difficult access. No roads or maintained trails provide ready access to the bottom of the gorge in the RNA. Recreational use in the gorge bottom thus requires extremely rigorous hiking upstream from below or downstream from above. Dense vegetation, boulders, debris jams and swift water make this journey formidable for any traveler. Though exact figures are not available, Forest recreation staff people estimate that the bottom of the gorge through the MCGRNA is traversed by fewer than 50 skilled adventurers per year. No obvious signs of dispersed recreational use such as fire rings, campsites, trash, etc., were seen in the lower third of the gorge that was visited during 1997 RNA field inventories.

Mill Creek Gorge is a popular rock climbing area in the vicinity of the La Sal Loop Road crossing. However, climbing does not currently occur in the gorge below the confluence of Horse Creek, and thus the MCGRNA does not contain established rock-climbing routes. Also, the RNA supports no established Outfitter and Guide activity.

Upper-elevation slopes above the cliffs of the gorge in the eastern third of the MCGRNA are relatively accessible to recreational visitors. However, these slopes of piñon-juniper or mountain brush vegetation seem to offer little that would attract recreational visitors that cannot be found and experienced in many other locations.

The undisturbed character and rugged remoteness of the MCGRNA, coupled with an increasing demand for primitive recreation opportunities, could result in increased recreational use in the area. However, the Forest will not be marketing, providing easier access, or otherwise drawing recreational attention to Mill Creek Gorge. No change in current recreation management direction or activity at Mill Creek Gorge is anticipated to result from RNA designation. The only consequence anticipated is that designation will preclude permitted use of the MCGRNA by Outfitter and Guide operations, which increasingly are seeking primitive adventure-type opportunities. Anticipated future recreational use levels are expected to be at low enough levels so as not to adversely affect the values for which the MCGRNA was designated.

Wildlife and Plant Values

Designation and management of the MCGRNA will maintain suitable habitat for special-status animals and plants that are known or likely to occur in the area.

Special Management Area Values

The MCGRNA does not contain or overlap with any Congressionally-designated areas.

Transportation Plans

The MCGRNA contains no routes that are open to motorized vehicles, nor roads or constructed/ maintained trails of any kind. The Forest Travel Map shows that Mill Creek Gorge is within an area where snow machines may operate on adequate snow, but the topography of the MCGRNA makes this type of activity extremely unlikely.

There are no transportation plans on the Manti-La Sal National Forest that would have direct adverse effects on the MCGRNA. Conversely, designation of the MCGRNA should have no effect on the Manti-La Sal National Forest transportation system.

MANAGEMENT PRESCRIPTION

In order to meet and maintain the objectives for which the MCGRNA is established (see the **OBJECTIVES** section of this Record), various management standards and prescriptions will apply to the area. General standards for RNA protection and management are contained in the Forest Service Manual, Section 4063.3. More specific management prescriptions for RNAs on the Manti-La Sal National Forest are contained within the direction for Management Unit RPI, which appears on pages III-83 through III-87 of the Forest Plan (USDA Forest Service 1986b); these pages are included in Appendix B of this Record. [Note: Because Management Unit RPI is not limited to Research Natural Areas, some of the Unit RPI stipulations are not applicable to RNAs.] A synopsis of the management standards and prescriptions for the MCGRNA, drawn from these sources, is provided below.

Emphasis for use of the MCGRNA is on research, study, observations, monitoring, and educational activities that are nondestructive and nonmanipulative. Management of the MCGRNA will be directed toward maintenance of unmodified conditions and natural ecological processes, as a source to compare with manipulated conditions outside of the area. Human activities that directly or indirectly modify ecological processes will not be permitted within the MCGRNA.

Use of the MCGRNA by scientists and educators is strongly encouraged. Cooperation with the Rocky Mountain Research Station is encouraged in order to accomplish research objectives. Special-use permits or cooperative agreements will be used to authorize and document scientific activity. Any public use that contributes to impairment of research or educational values will be discouraged or prohibited. Surface resource conditions will be protected to prevent alteration of research projects. Guidelines for scientific and educational use of the MCGRNA are contained in FSM 4063.33.

Logging activities, harvest of woodland products, fuelwood gathering, Christmas tree gathering, and direct habitat manipulation for wildlife are prohibited within the MCGRNA. The District and Forest should show the MCGRNA as a closed area on firewood and Christmas tree cutting maps that are distributed to the public.

Livestock grazing will not be used as a management tool to maintain vegetation communities in the MCGRNA. Maintenance of the current grazing situation on the Brumley Ridge cattle allotment, within which the MCGRNA lies, will result in an acceptable level of casual or incidental livestock use that can be tolerated within the MCGRNA. Construction of range improvements is prohibited within the MCGRNA, and other management actions will not be taken to encourage livestock usage at greater than current levels within or toward the vicinity of the MCGRNA. Overnight pasturing of recreational pack stock is not permitted within the MCGRNA.

Placement of recreation facilities and establishment of permanent camps are prohibited within the MCGRNA. Use of the MCGRNA by Outfitter and Guide operations will not be permitted. Other recreational use of the MCGRNA is not expressly prohibited, but such use will not be encouraged so that the scientific and educational values of the area can be emphasized. The effects of recreational uses (if any) that occur within the MCGRNA will be evaluated periodically. Any such uses that are found to be threatening or interfering with the objectives for which the MCGRNA was established will be prohibited. Indicators of unacceptable degradation include the appearance of social trails, permanent rock climbing equipment, creation of campsites, campfire rings, unnatural erosion patterns, and other indications of significant recreational use.

No roads, trails, fences, signs, buildings, administrative structures or other physical improvements will be permitted within the MCGRNA, unless they are necessary for research or study purposes or otherwise contribute to the objectives or protection of the area. The Forest Plan allows for the presence of instrumentation to measure precipitation and climate variables needed for research study purposes; FSM 4063.31 contains procedures for authorizing temporary physical improvements.

Water impoundment structures, water developments and watershed protection activities are prohibited within the MCGRNA.

Special closures may be used when necessary to protect the MCGRNA from actual or potential damage from public use, or to prohibit uses that are incompatible with the area's objectives, according to provisions of 36 CFR 261.50 (see also FSM 4063.3.6).

Fire hazard will not be reduced within the MCGRNA. Natural fires within the MCGRNA will be allowed to burn only within the parameters of an approved fire plan, and only under a prescription designed to accomplish the objectives of the area. Until such a plan has been approved by the Regional Forester in consultation with the Rocky Mountain Research Station Director, fires will be suppressed using means that will cause minimal damage to the MCGRNA. Use of heavy equipment in suppression efforts is strongly discouraged, and should be used only as a last resort. Use of chemical fire retardants in the MCGRNA likewise is strongly discouraged. Fire-caused debris will be left for natural decay, and post-fire rehabilitation is not recommended. If such rehabilitation must be done, as in cases of extreme flood or erosion hazards to people or property outside the MCGRNA, then only seeding with locally adapted ecotypes of indigenous species should be utilized.

No actions will be taken against endemic insects, diseases, wild plants or animals in the MCGRNA, unless the Regional Forester and Station Director deem such actions necessary to protect the features for which the MCGRNA was established or to protect adjacent resources.

Introduction or spread of exotic plant or animal species into the MCGRNA is prohibited, and precautions will be taken to avoid such introductions. If re-seeding is needed following a fire (as mentioned above), then the seed mix will not contain non-native plant species. If pack stock are determined to be a vector for introduction of non-native plant species, then weed-free feed requirements will be implemented. Insofar as is practical, measures will be taken to control or eradicate existing or new occurrences of exotic plant or animal species from the MCGRNA, particularly those that readily invade native communities and/or alter natural ecological conditions. Where pest management or noxious weed control activities are necessary within the MCGRNA, they will be as specific as possible against target organisms, and will induce minimal impacts to natural values and other components of the ecosystem.

The Forest Plan (page III-86) calls for withdrawal of the MCGRNA from mineral entry if such action is needed to protect the area's values. Mineral withdrawal would be in conformance with section 204 of the Federal Land Policy and Management Act of 1976 (90 Stat. 2743, 43 U.S.C. 1701; FSM 2761). Failure to achieve such a withdrawal will not be a deterrent to the continued RNA status of the Mill Creek Gorge area (FSM 4063.2).

Mineral lease applications, permits and licenses within the MCGRNA will be reviewed and processed in a timely fashion, recommending to the Bureau of Land Management such measures and stipulations as necessary to protect surface resources. New leases within the MCGRNA will include the stipulation for No Surface Occupancy. Seismic and prospecting activities are prohibited in the MCGRNA.

Utility corridors are excluded from the MCGRNA. The powerline that crosses over Mill Creek Gorge near the upper eastern end of the MCGRNA will remain in place, because it pre-dates the establishment of the RNA and its support towers lie outside the RNA boundary.

Vegetation Management

As mentioned above in the **MANAGEMENT PRESCRIPTION** section, domestic livestock grazing will not be used as a management tool to maintain vegetation communities in the MCGRNA.

Fire plays an important functional role in several of the upland shrub- and tree-dominated communities represented in the MCGRNA. Over time, fire suppression alters the "natural" or pre-settlement fire regime in these communities, and leads to changes in their structure and function. In the long term, continued fire suppression may even convert these communities into types whose response to fire is entirely unpredictable.

Therefore, inventory, monitoring and research should emphasize the role of fire as a natural process governing these upland shrub and tree communities, and evaluate the risk of continued wholesale fire suppression. Such knowledge should be incorporated into an approved fire plan for that portion of the Forest in which the MCGRNA lies, and allow for conditions under which certain naturally-ignited fires may be allowed to burn within the MCGRNA. Such a plan will identify those parts of the MCGRNA that are allocated for prescribed non-suppression of naturally ignited fires, and those parts that are reserved for permanent suppression of fire (per FSM 4063.41.5.j(1)).

Monitoring

To ensure that only authorized use is occurring and to determine if any threats may be imminent, the MCGRNA should be visited annually or biennially by Forest Service personnel or a cooperative partner. A stewardship monitoring module prepared by the Natural Areas Program Office in Missoula MT is available for use in documenting the results of such general monitoring visits.

Establishment of permanent monitoring plots is encouraged within the MCGRNA. These would provide information required to manage effectively and protect the area over time. Long-term ecological monitoring in RNAs will make significant contributions to understanding of how ecosystem patterns and processes change over time.

ADMINISTRATION, RECORDS AND PROTECTION

Administration, records and protection of the MCGRNA are the ultimate responsibility of the Director of the Rocky Mountain Research Station. The Station Director, in consultation with the Forest Supervisor, Manti-La Sal National Forest, and District Ranger, Moab/Monticello Ranger District, will approve all management plans and oversee and coordinate approved research. The Forest Supervisor will execute approved management plans for the MCGRNA and administer, manage and protect the area. The District Ranger has responsibility for direct administration, protection and management of the MCGRNA in accordance with this Establishment Record, Forest Plan management direction, and any subsequent management plans for the MCGRNA.

Requests to conduct research within the MCGRNA are referred to the Station Director, who will be responsible for any studies or research conducted. The Station Director will evaluate research proposals, and will coordinate the activity with the District Ranger prior to the initiation of any project. All plant and animal specimens collected in the course of research conducted in the MCGRNA will be deposited with the Monte L. Bean Life Science Museum and Herbarium at Brigham Young University, and/or with federal agency herbaria and museums approved by the Station Director.

Records for the MCGRNA will be maintained in the following offices:

Intermountain Region, Ogden, UT
Manti-La Sal National Forest, Price, UT
Moab/Monticello Ranger District, Monticello, UT
Rocky Mountain Research Station, Ogden, UT

ARCHIVING

The Research Natural Area Coordinator at the Intermountain Regional Office, Ogden, UT, will be responsible for maintaining the MCGRNA research data files, including studies conducted in the MCGRNA, lists of plant and animal species and plant communities occurring within the MCGRNA, and lists of herbarium and museum specimens collected. Descriptive data from the MCGRNA will also be stored in the computerized natural areas database maintained by the Utah Natural Heritage Program in Salt Lake City, UT.

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